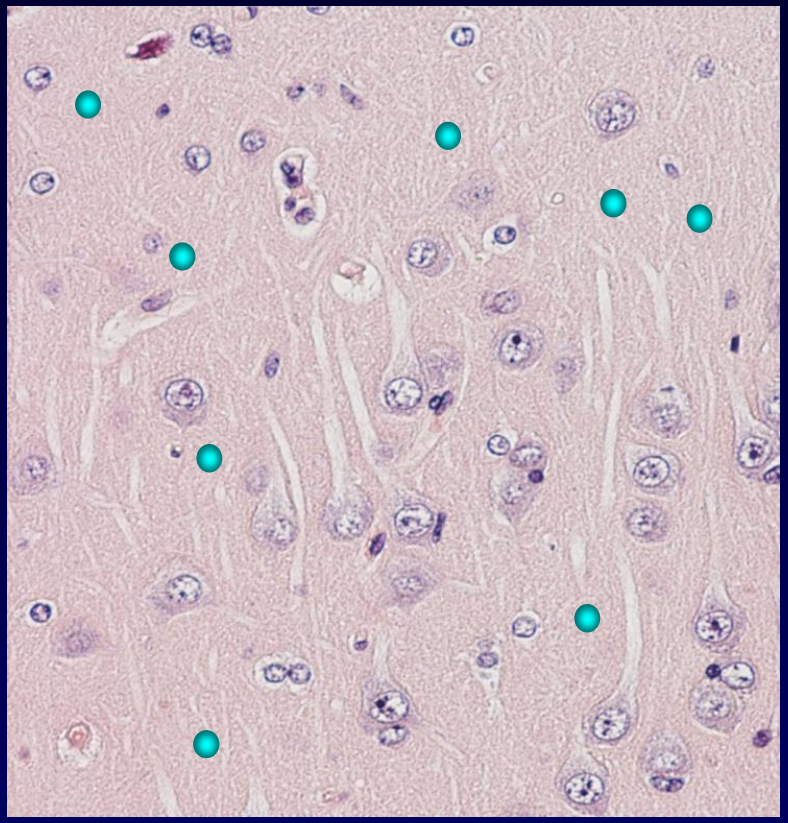
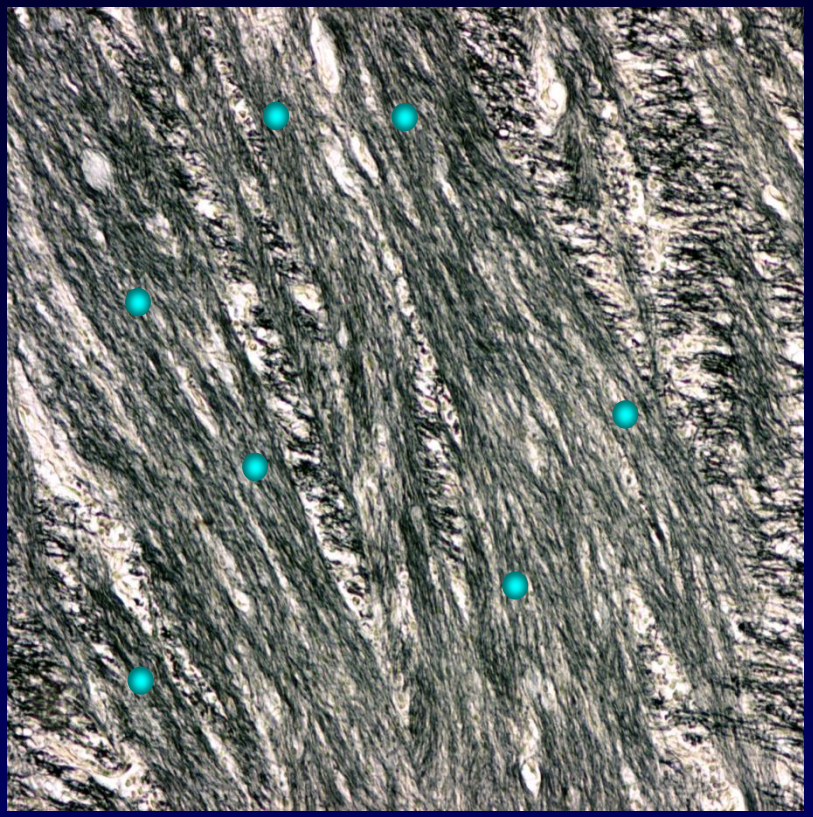
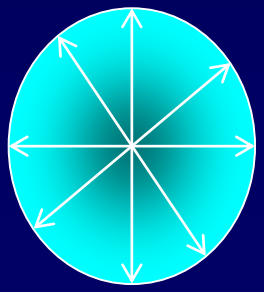
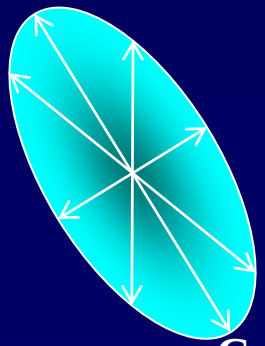
DIFFUSION-DIFFUSION TENSOR IMAGING

Isotropy and anisotropy

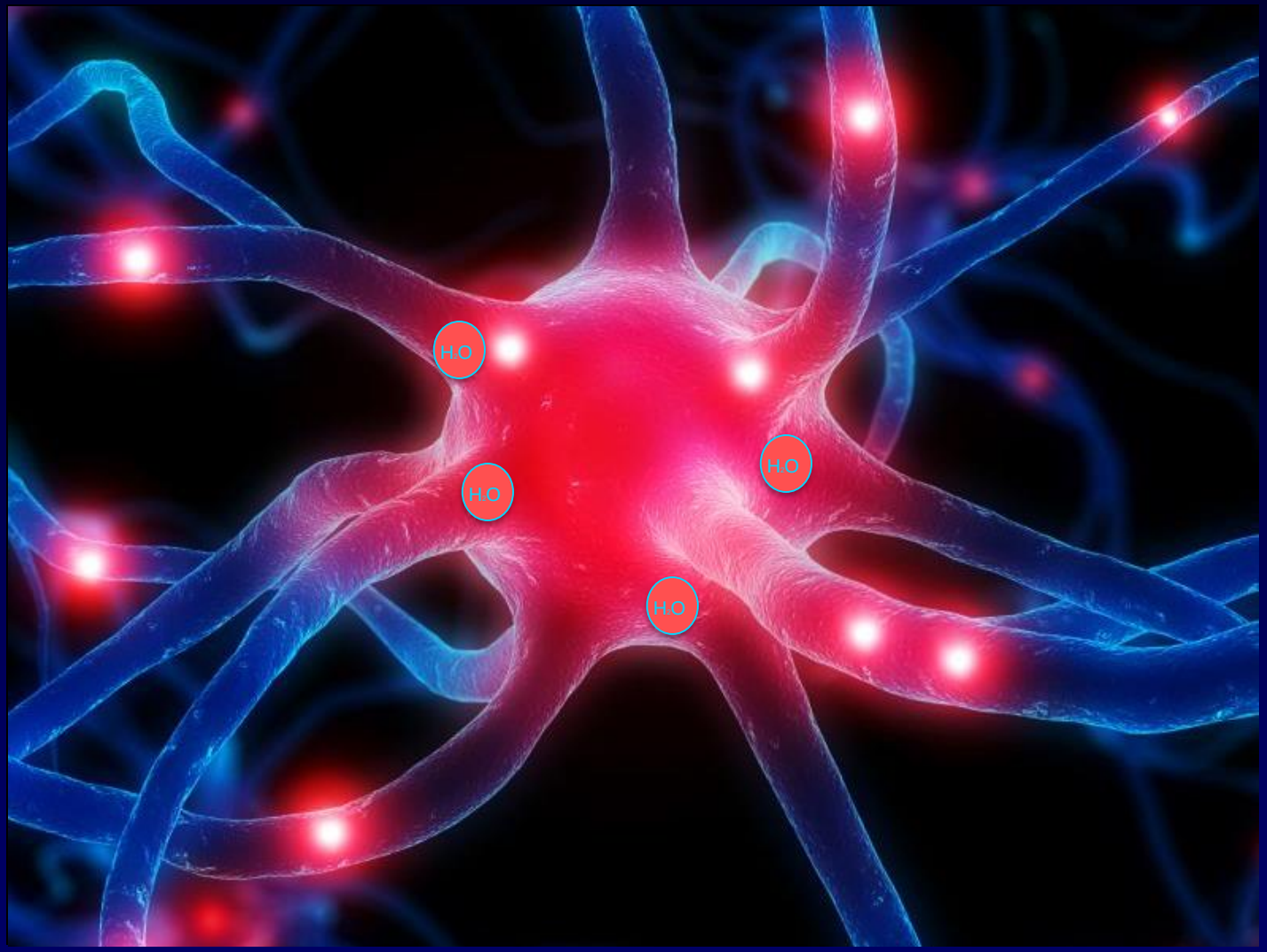








Courtesy A Bizzi


H2O
H2O
H2O
H2O

DIFFUSION-DIFFUSION TENSOR IMAGING

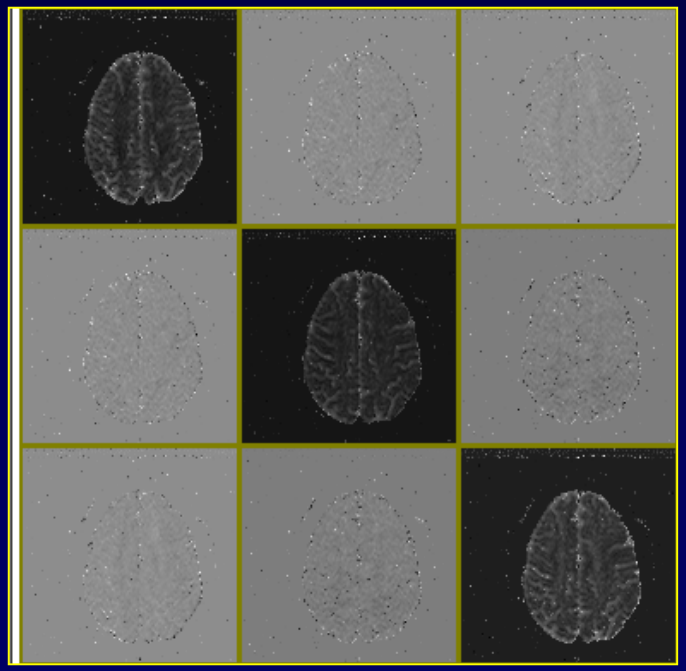
- Diffusion tensor imaging (DTI)

  - diffusion tensor imaging maps: mean diffusivity (*D*), *fractional anisotropy (FA), relative anisotropy (RA)*.....

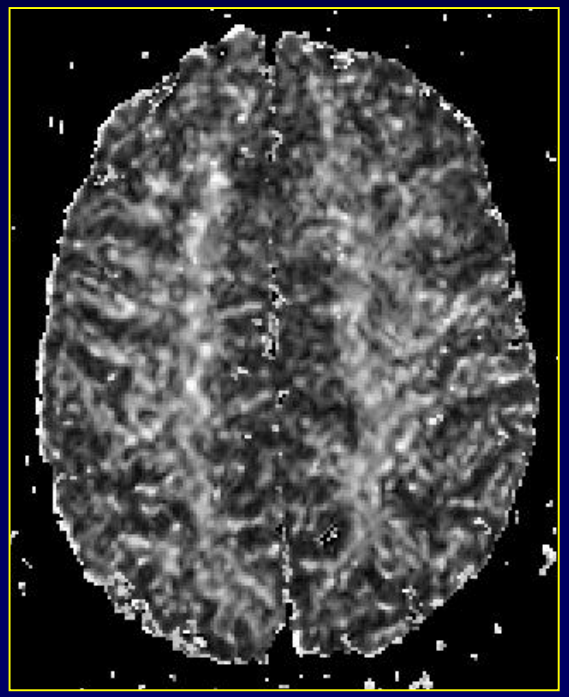
  - tractography

Diffusion tensor imaging

- Describes the white matter anisotropy



Trace-MD



FA

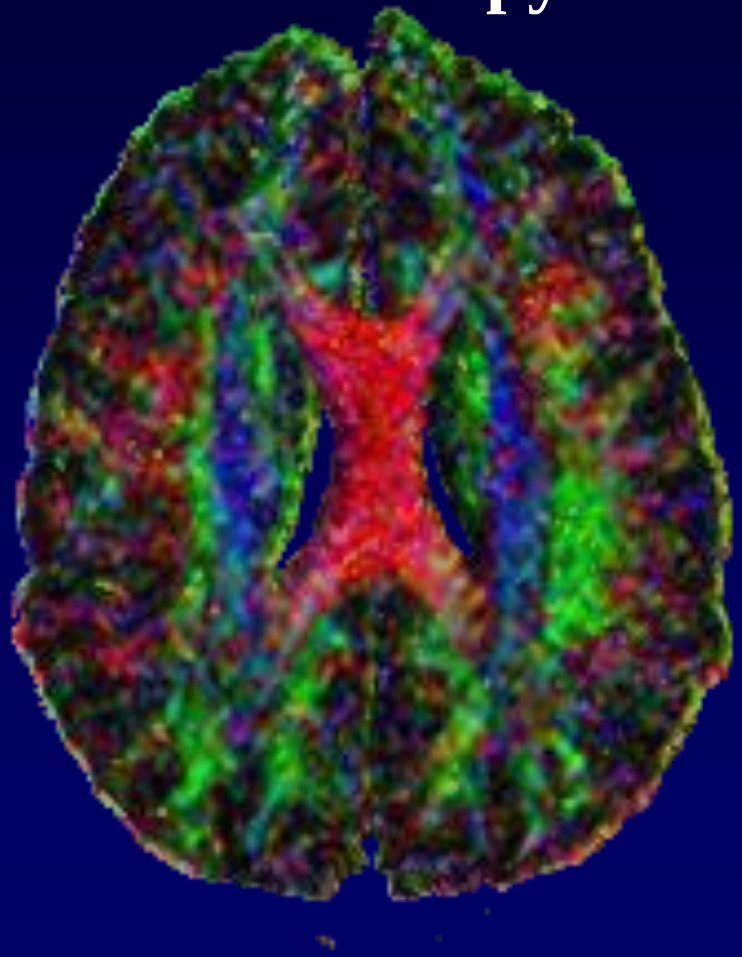
Color maps-tractography

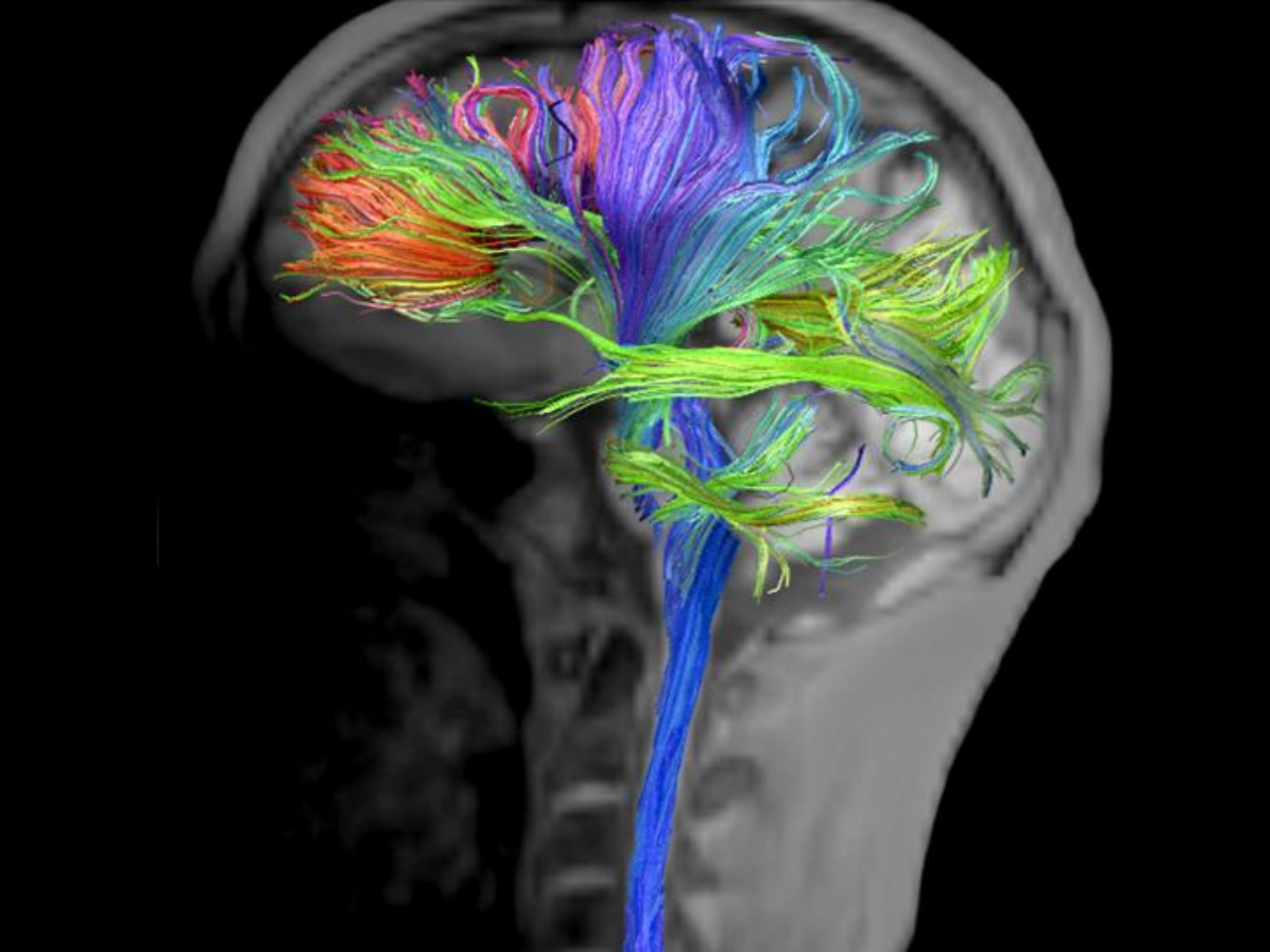
- **Information about the direction of anisotropy**

= X (right-left)

= Y (anterior-posterior)

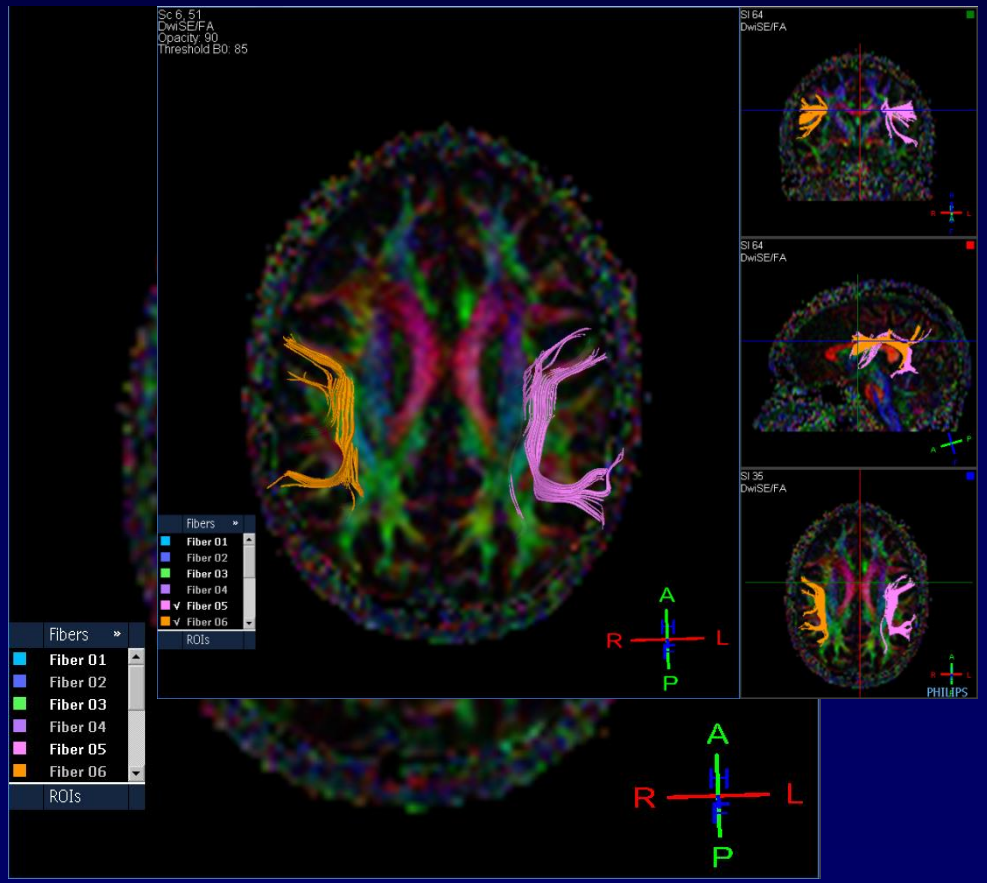
= Z (cranio-caudal)

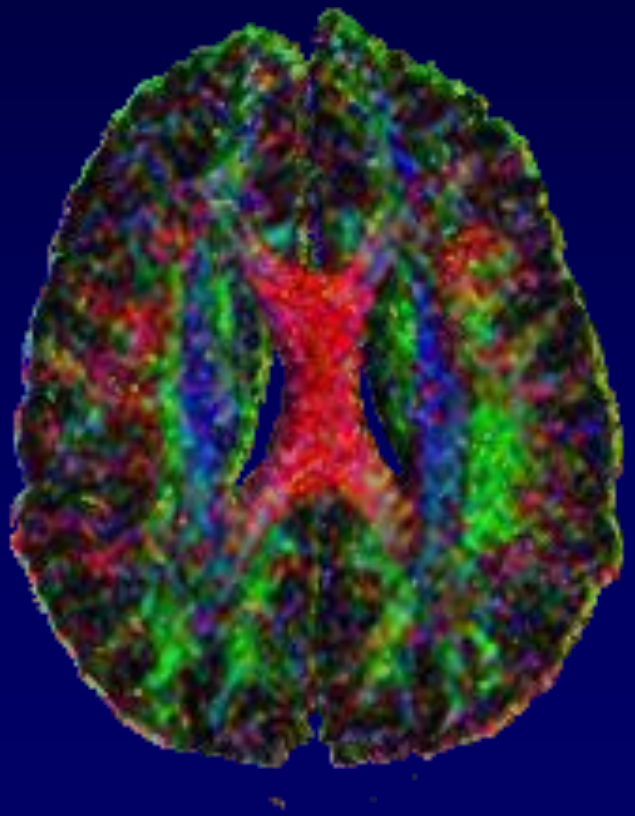




Tractography

- *Evaluation of white matter tract*





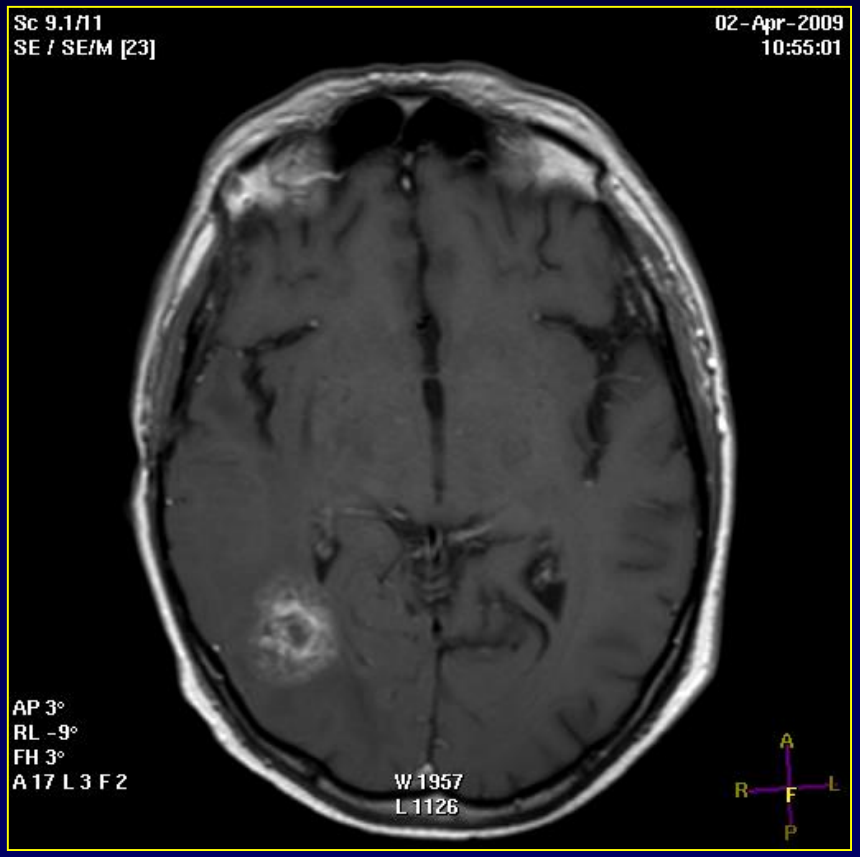
Diffusion tensor imaging

Tumors

- ↓ FA surrounding high grade gliomas compared to areas surrounding meningeal tumors

- Evaluation of myelinated fibers which could be infiltrated, destroyed or compressed

→ could be important for surgery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RL -9°
FH 3°
A 17 L 3 F 2
W 1957
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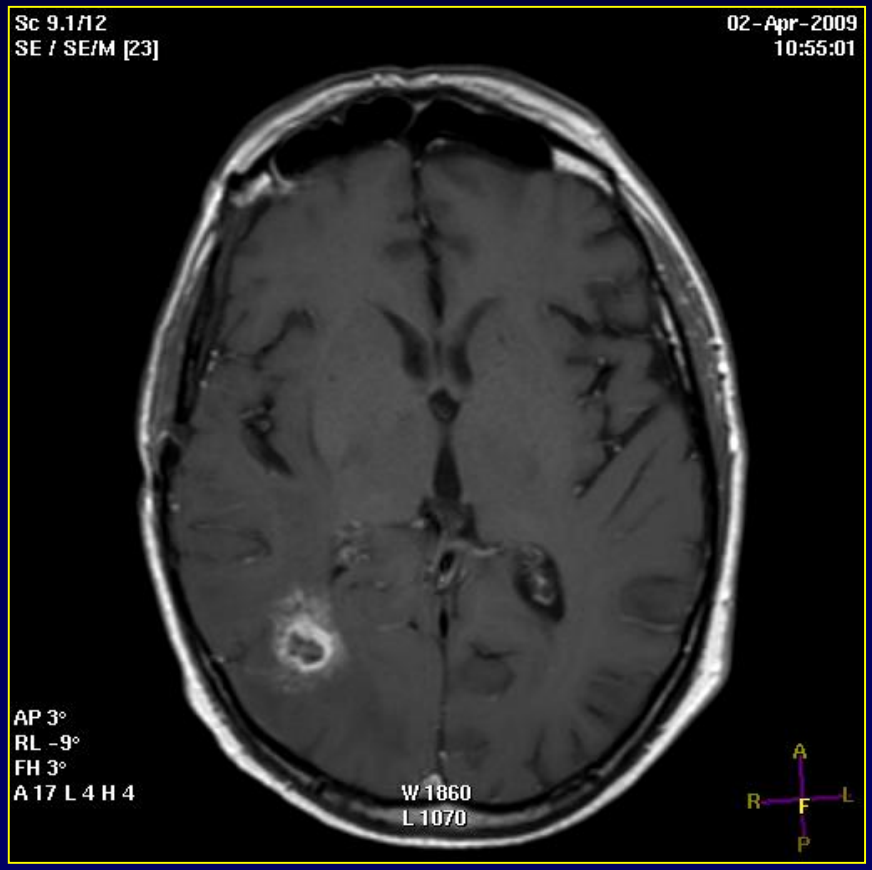
A
R
F
L
P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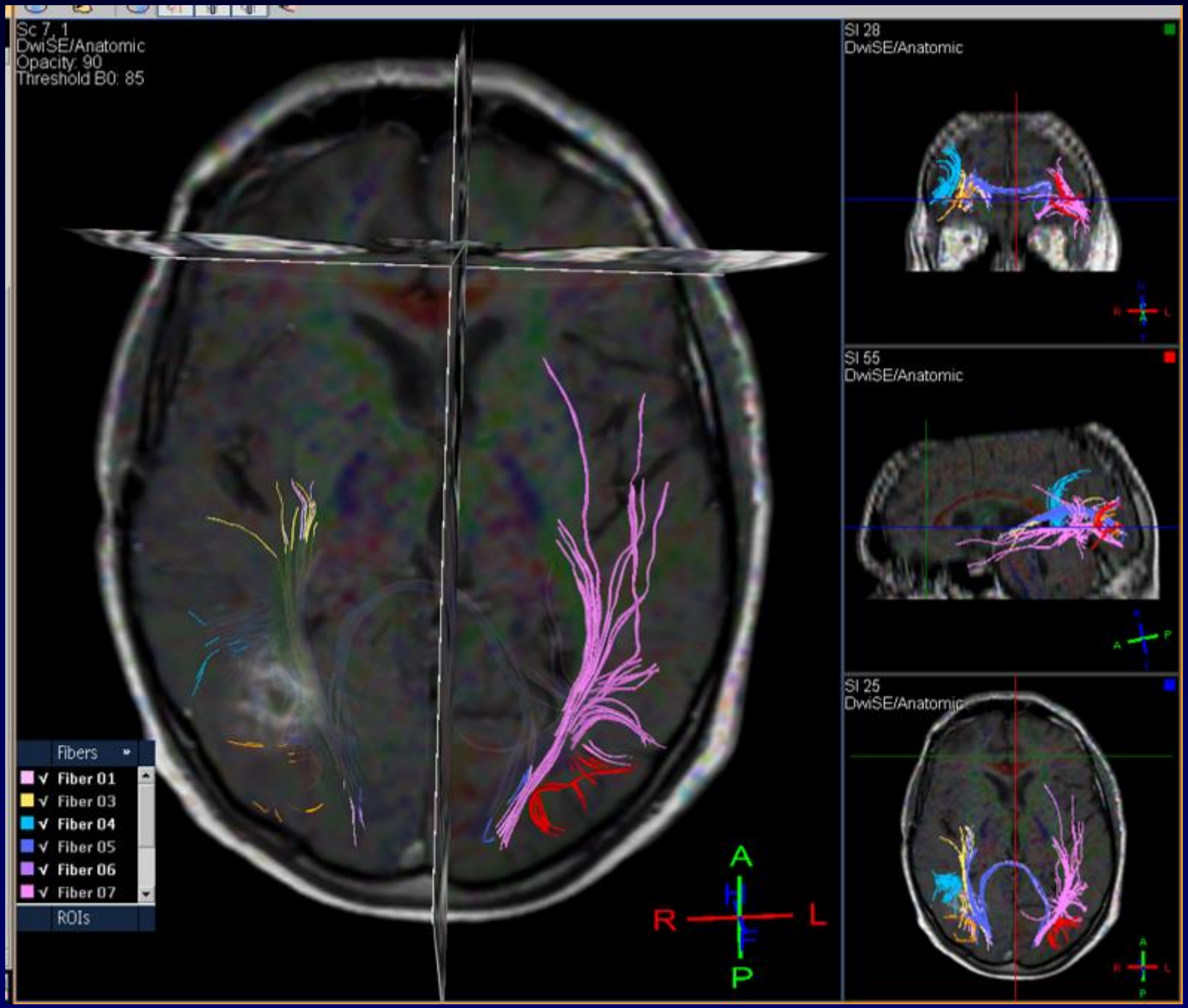
Sc 7. 1
DwiSE/Anatomic
Opacity: 90
Threshold B0: 85
SI 28
DwiSE/Anatomic
SI 55
DwiSE/Anatomic
SI 25
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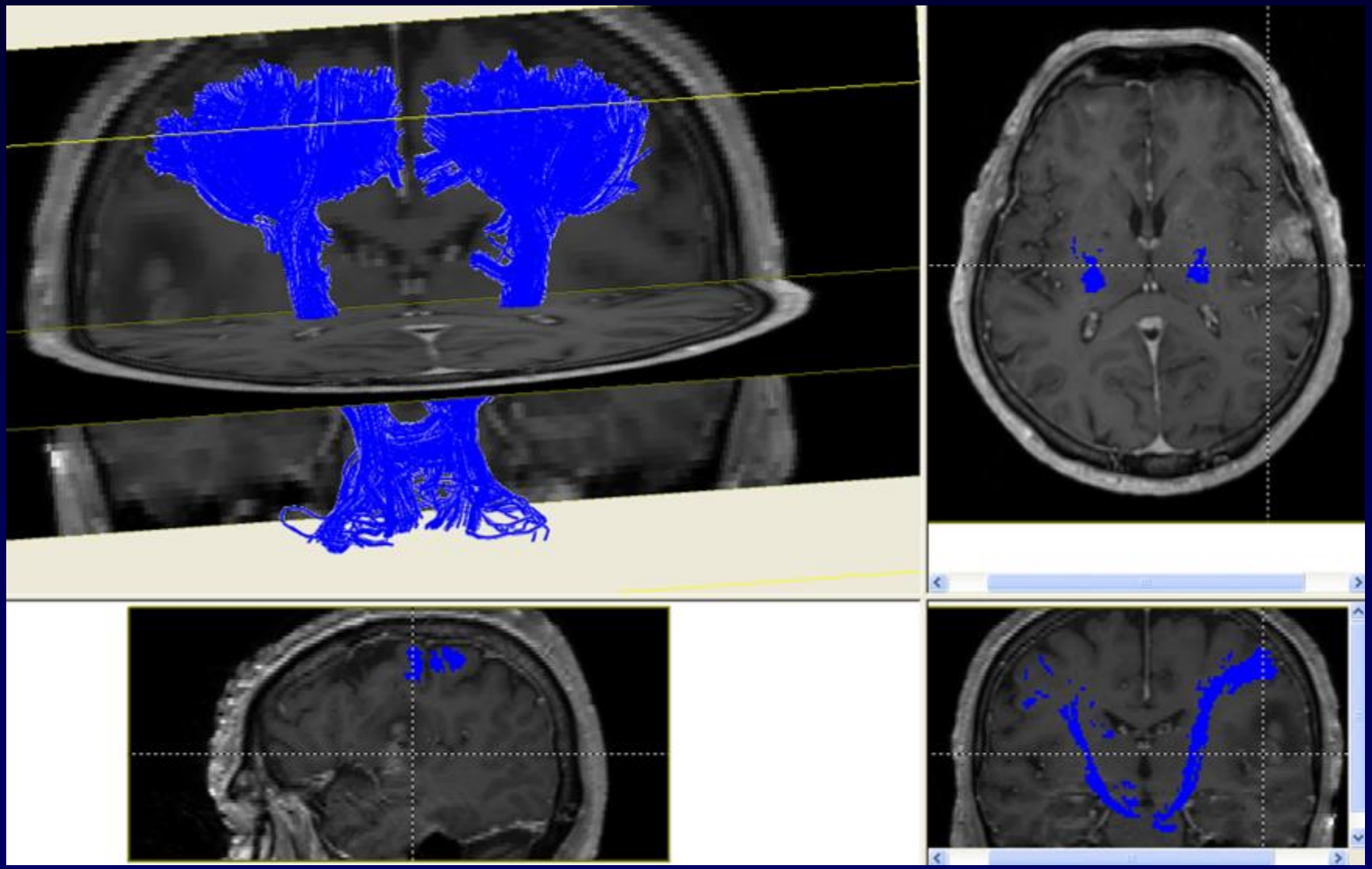
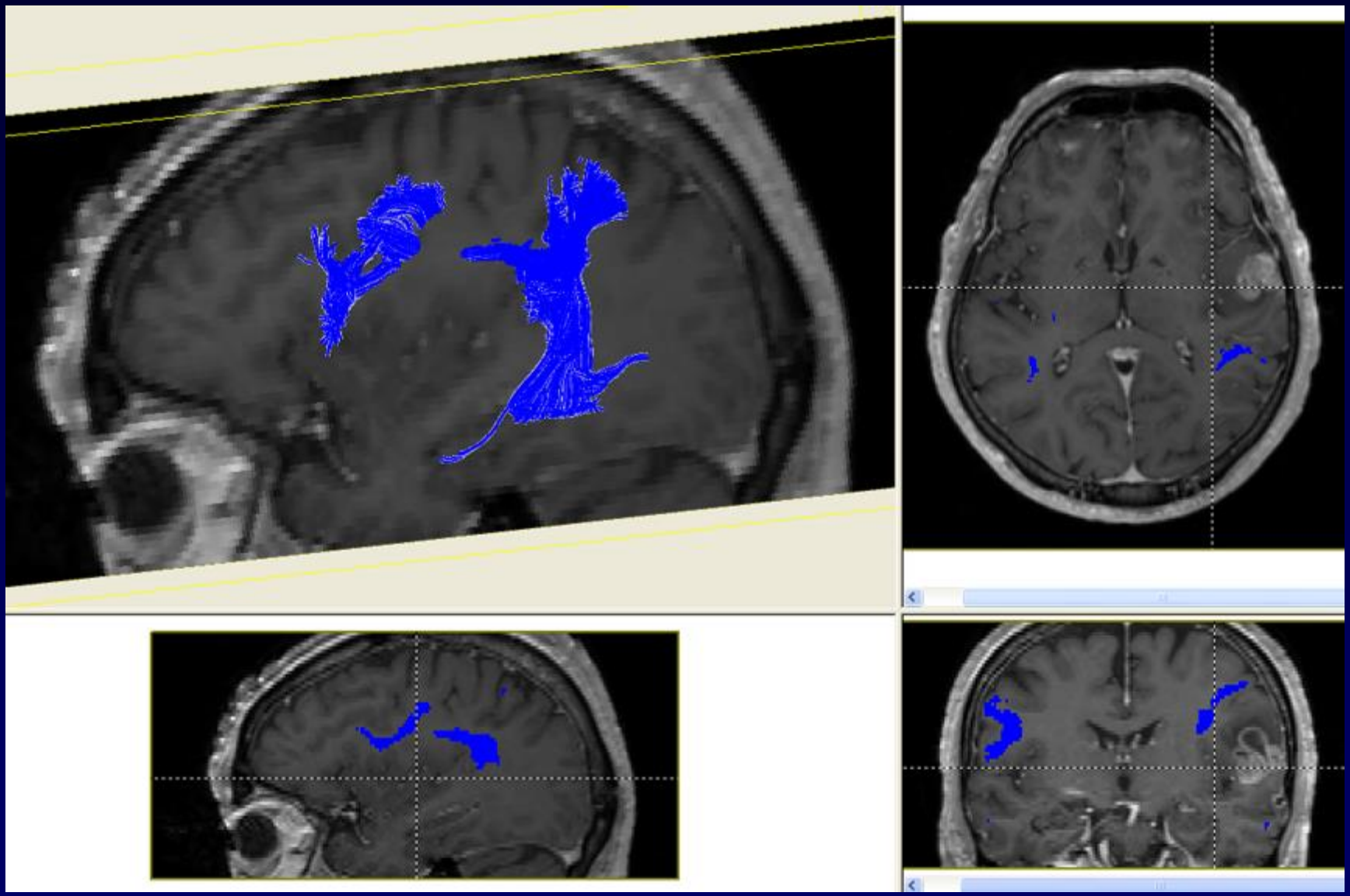
Fibers
Fiber 01
Fiber 03
Fiber 04
Fiber 05
Fiber 06
Fiber 07
ROIs
A
R
L
P

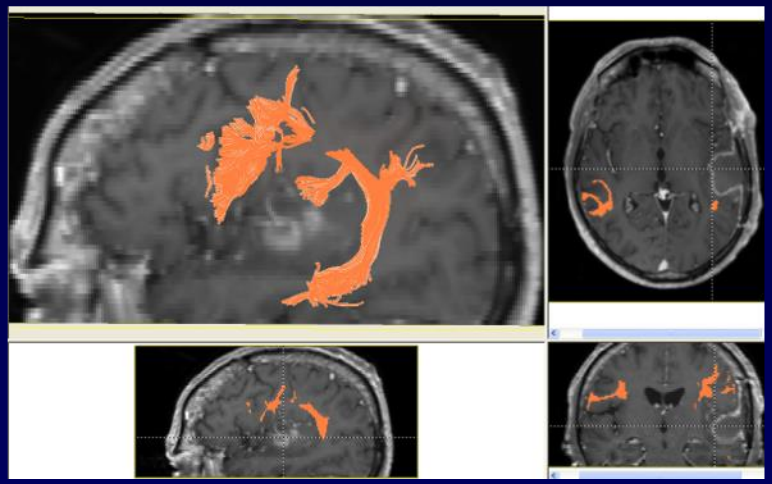


Courtesy of L. Weis

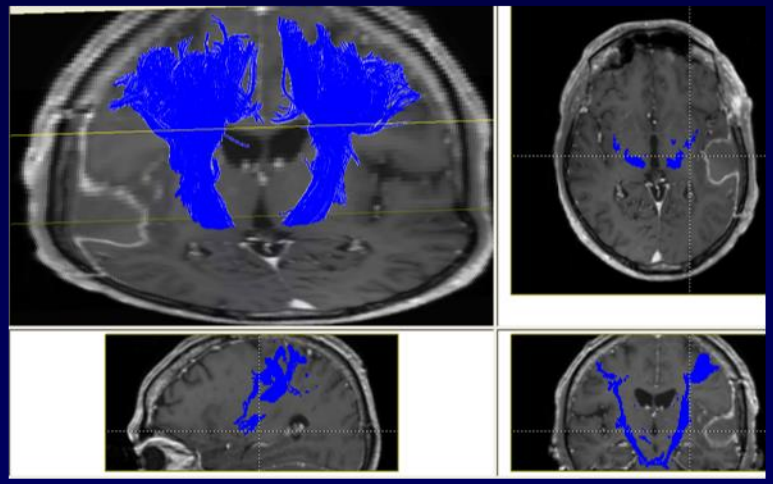


Courtesy of L. Weis

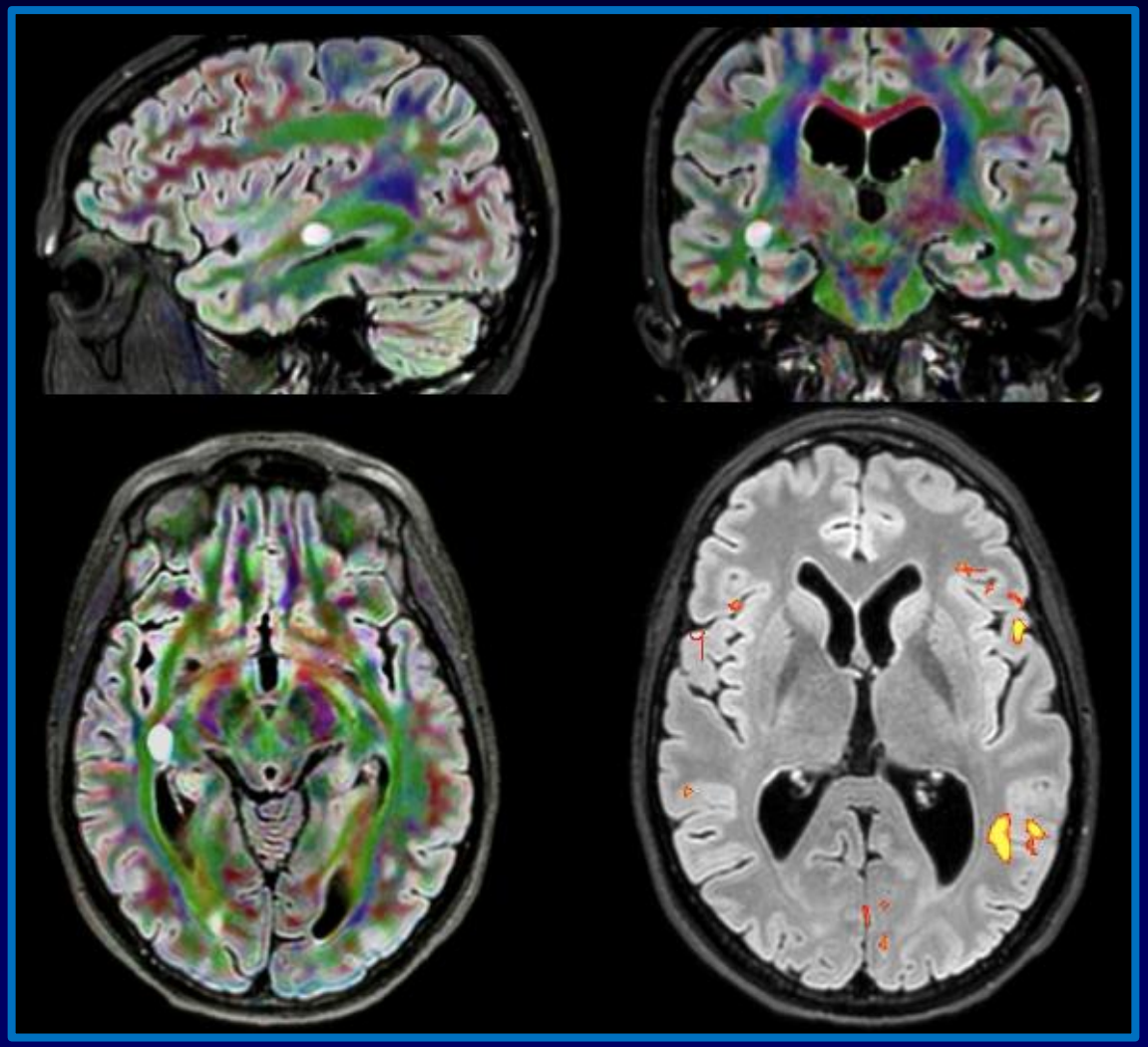
Arcuate fasciculus



Corticospinal tract

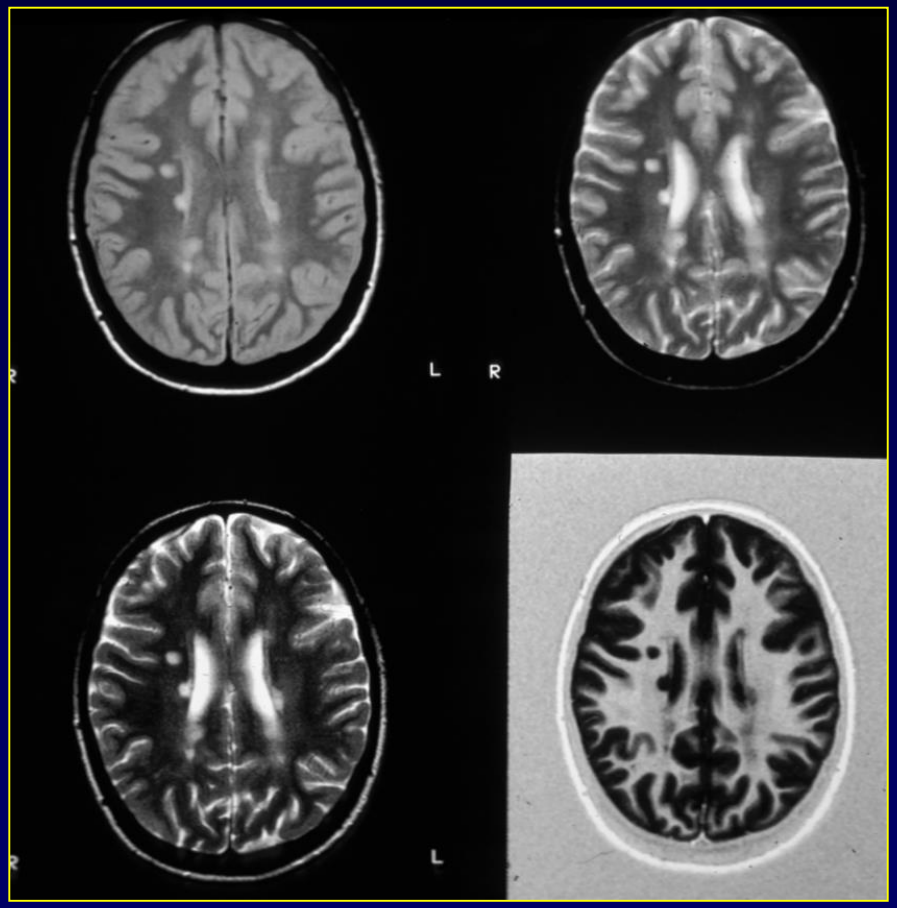


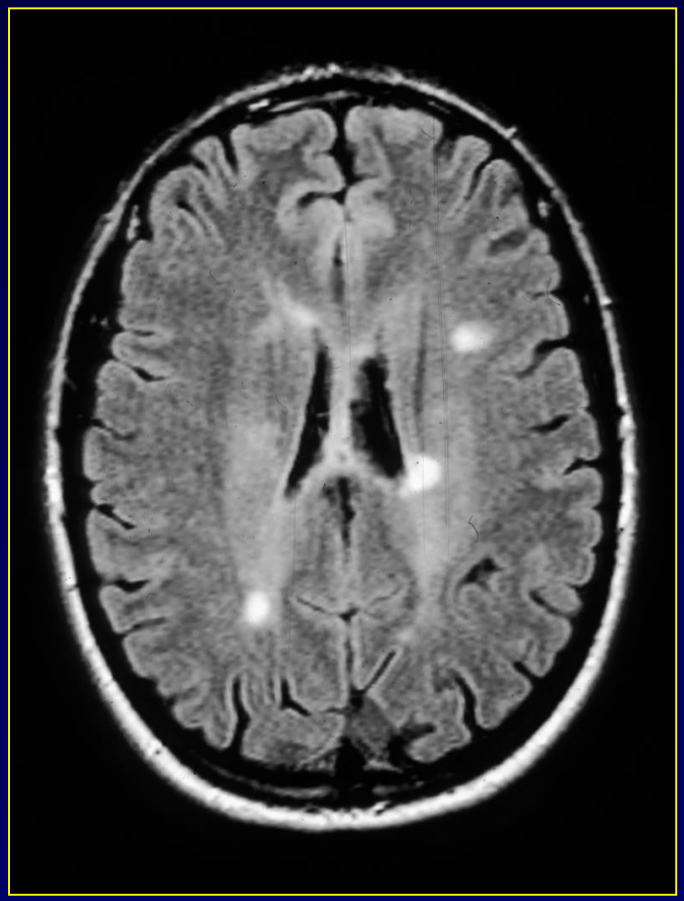
Courtesy of L. Weis



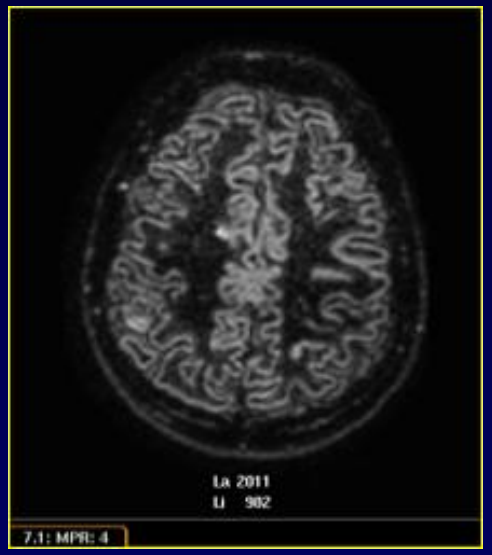
Diffusion tensor imaging

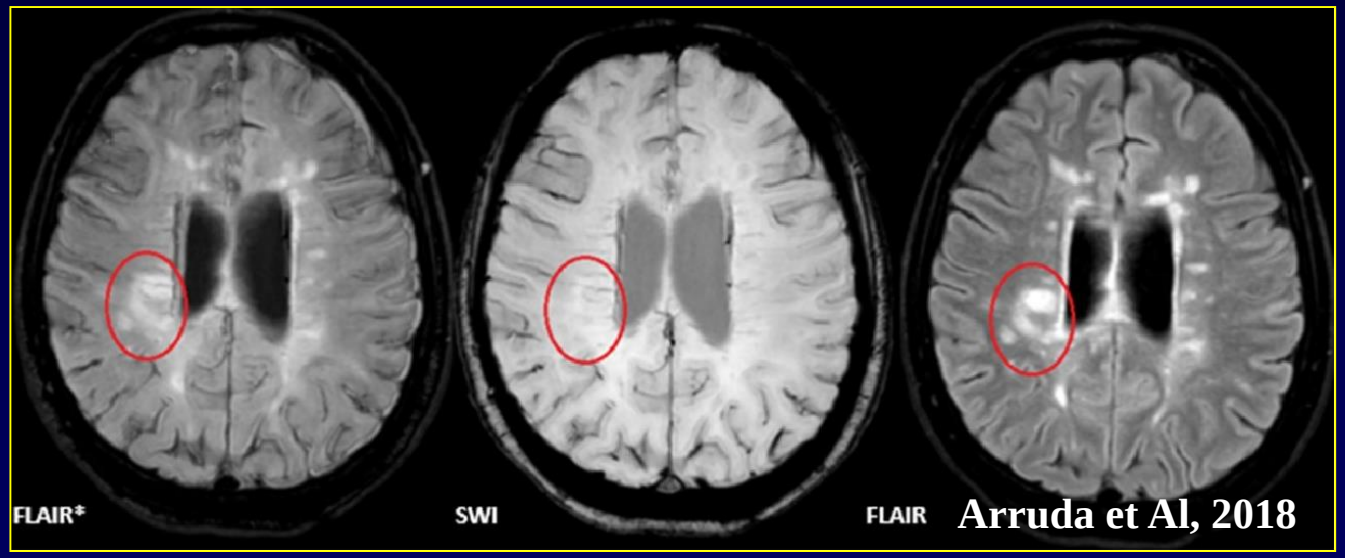
Multiple sclerosis





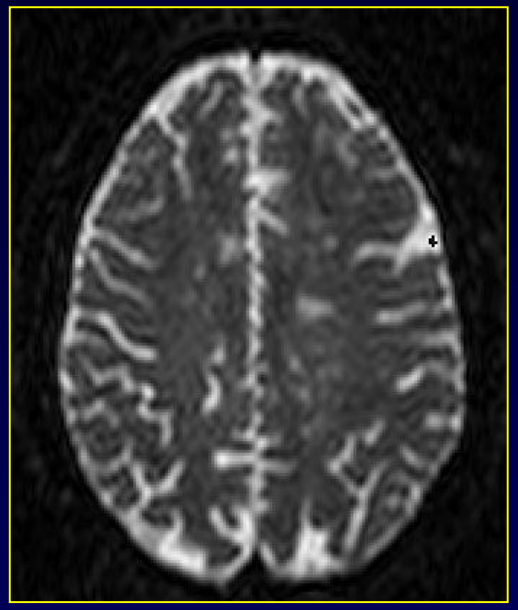
Multiple sclerosis





Diffusion tensor imaging

Multiple sclerosis



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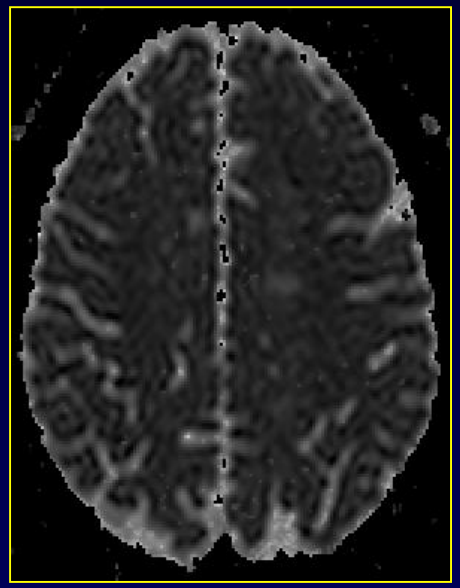

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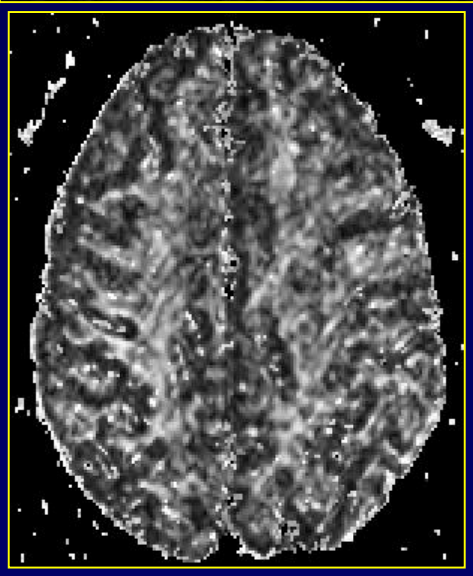
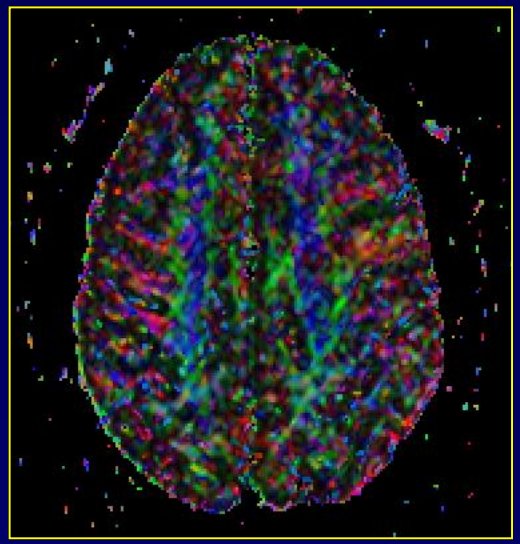


FA



Color map

Diffusion tensor imaging
Multiple sclerosis

Location	Side	FA (mean ± SD)		MD (mean ± SD) 10^{-3} mm^2 s^{-1}	
		RRMS	Control	RRMS	Control
SCR	Left	0.3816 ± 0.0375	0.4307 ± 0.0577	0.7769 ± 0.0664**	0.6785 ± 0.0199
SCR	Right	0.3918 ± 0.0331	0.4824 ± 0.0450	0.7976 ± 0.0731**	0.6954 ± 0.0429
SLF	Left	0.3418 ± 0.0221	0.3769 ± 0.0386	0.8127 ± 0.0618	0.7523 ± 0.0380
SLF	Right	0.3377 ± 0.0352	0.3871 ± 0.0458	0.8106 ± 0.0510	0.7611 ± 0.0333
ACR	Left	0.3425 ± 0.0400**	0.3975 ± 0.0200	0.8397 ± 0.0716**	0.7418 ± 0.0226
ACR	Right	0.3390 ± 0.0393**	0.4034 ± 0.0292	0.7403 ± 0.0817**	0.8474 ± 0.0279
BCC	–	0.3831 ± 0.0389**	0.4503 ± 0.0334	1.0156 ± 0.1421	0.9606 ± 0.1271
CIN	Left	0.2707 ± 0.0423	0.3045 ± 0.0514	0.8690 ± 0.0659	0.8140 ± 0.0377
CIN	Right	0.2642 ± 0.0381	0.0304 ± 0.0460	0.8361 ± 0.0586	0.7950 ± 0.0510
EC	Left	0.3295 ± 0.0221	0.3423 ± 0.0205	0.8242 ± 0.0569	0.7698 ± 0.0392
EC	Right	0.3294 ± 0.0213	0.3331 ± 0.0191	0.8322 ± 0.0504	0.7775 ± 0.0243
GCC	–	0.3549 ± 0.0423**	0.4227 ± 0.0369	1.1287 ± 0.0906	1.0199 ± 0.0898
PTR	Left	0.4035 ± 0.0614	0.4472 ± 0.0318	0.945 ± 0.1245	0.8181 ± 0.0534
PTR	Right	0.3930 ± 0.0508*	0.4534 ± 0.0266	0.8538 ± 0.0974	0.7432 ± 0.0832
SCC	–	0.4159 ± 0.0464**	0.5087 ± 0.0393	1.1251 ± 0.1456	1.0363 ± 0.0937
TAP	Left	0.3685 ± 0.0540	0.3703 ± 0.0965	1.2971 ± 0.2899	1.5991 ± 0.3597

*Significant differences of FA and MD between RRMS patients and healthy controls are shown by FDR adjusted *$p < 0.01$ and highly significant differences by **$p < 0.001$.*

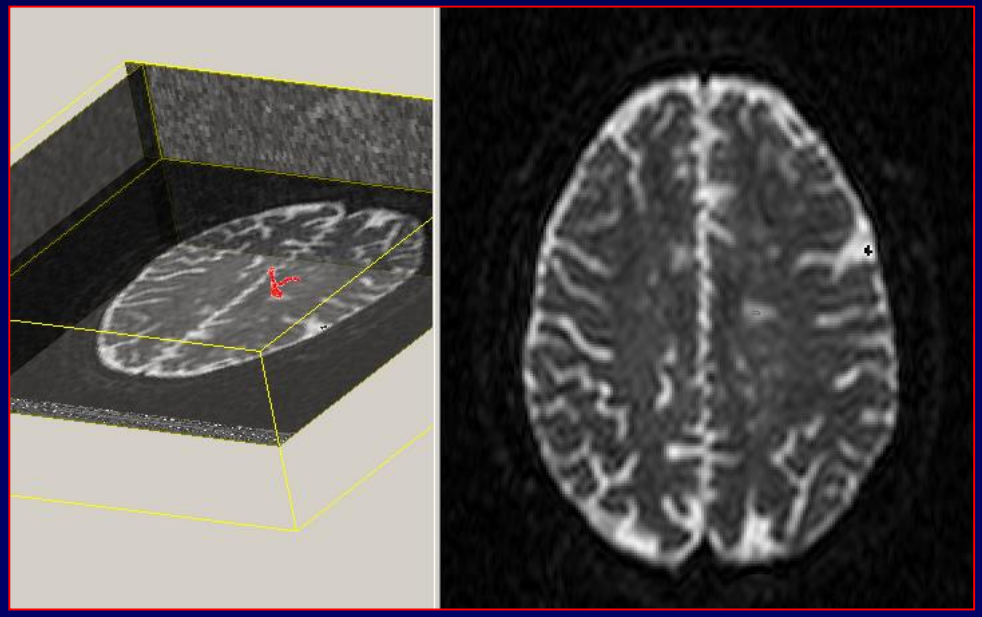
Bao et al, *Front. Neurosci. 2022*

Diffusion tensor imaging

Tractography

Multiple sclerosis

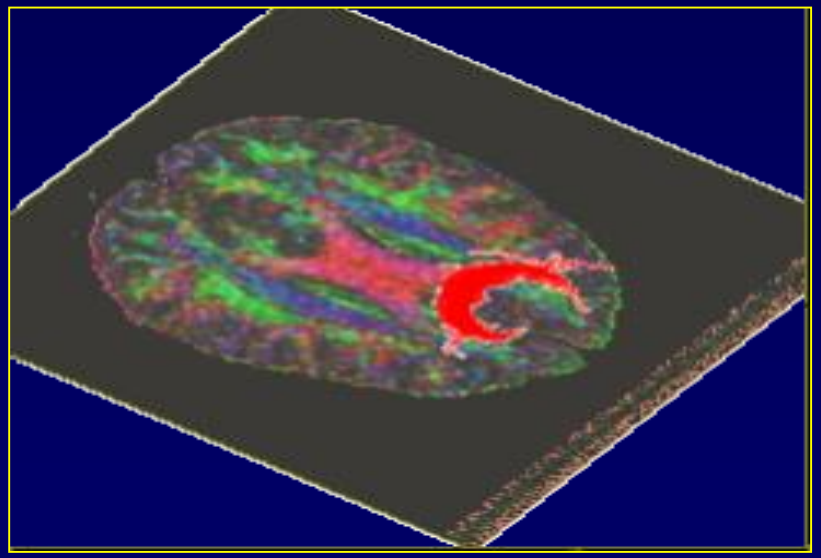
- Better correlation with disability
- Higher specifity ???



Diffusion tensor imaging

Aging brain – Degenerative disorders

- **Moderate increase of *D* with aging**
- **Reduction of FA with aging at the level of corpus callosum and frontal lobe**
- **Reduction in the number of fibers**



Diffusion tensor imaging

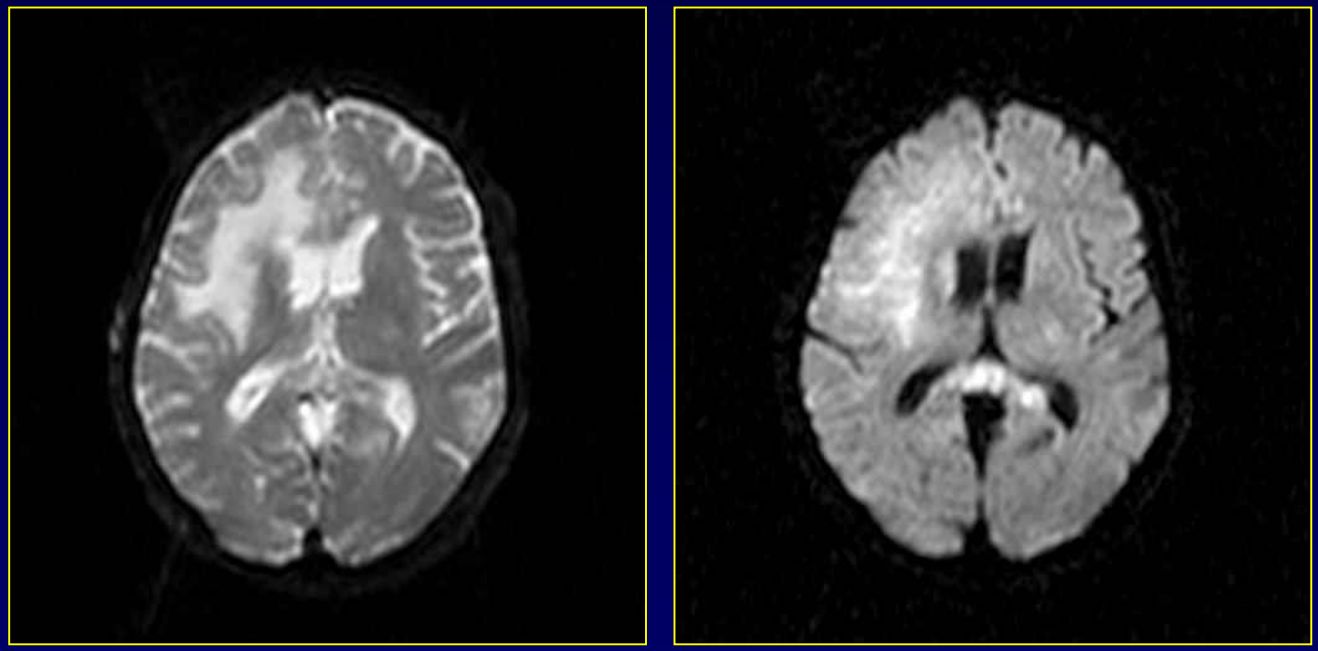
Aging brain – Degenerative disorders

Alzheimer disease

- ↓FA in particular at the level of corpus callosum and frontal lobes
- Correlation with neuropshicological tests
- Both in MCI and AD: reduced FA at the level of splenium and temporal cortex

DIFFUSION WEIGHTED IMAGES

- Routinely use in clinical setting, in particular in ischemic disease, infection….



DIFFUSION TENSOR IMAGING

- Allows better evaluation and comprehension of several disaease, mainly related to white matter pathology
- Not routinely use, research purposes

- Preoperative evaluation of brain tumors (tractography)

- Problems: metodology, magnet, software dependent….difficult to compare different studies